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Editorial Notes

Preparing for Peak Loads

THE annual reports of many electricity undertakings for the last financial year show how disastrous the cold snap has proved to them. December of 1938 brought home to undertakings supplying electricity at low rates for domestic purposes that poor load factor heavy current consuming apparatus can create an unpleasant situation. During the cold spell increase in maximum demands was due to heating apparatus with negligible load factor. Now we have the actual figures of the losses sustained ; and an electrical contemporary remarks that " the affliction was fairly widespread among concerns taking a bulk supply from the Central Electricity Board."

Now the electricity industry has not the storage facilities which the Gas Industry enjoys and which, coupled with the very great flexibility of gas-making plant, renders the problem of meeting peak loads a very much simpler one. That the unprecedented demands made upon the Industry during the six days ended on Dec. 22, 1938—the increase being 2,000 million cu.ft. on the previous six days—were met gives a measure of the Industry's remarkable flexibility and the value of its storage capacity.

But the problem will not tend to become easier. Thousands and thousands of space heating appliances are being installed and more two-part tariffs or other promotional rates for gas are being adopted which makes the use of gas for heating competitive with raw coal. Every gas appliance installed for continuous heating will have a marked effect on the peak load caused by seasonal changes and even day to day changes in weather conditions ; and it would be well if those undertakings which, obviously quite rightly, have put into operation promotional rates for gas asked themselves whether they are fully satisfied as to their preparedness to cope with the very large increases in peak loads which are certain to result from the replacement of coal by gas. One has only to have regard to the phenomenal peak loads experienced by the American Gas Industry since the adoption several years ago now of attractive rates for gas to appreciate that the problem is one which demands the serious attention of gas engineers in this country. Gas at 4d. or thereabouts a therm will change the peak load situation enormously.

Had it not been for the bringing into operation of water gas plant at full pressure, many undertakings would have been unable to cope with last December's peak load demand. The usefulness of having carburetted water gas plant as an auxiliary to coal gas plant was appreciated at that time more perhaps than ever before. And, as we have said, gas at 4d. a therm will entirely alter the incidence of the peak load and render carburetted water gas of greater importance. If we are to meet the demand while making gas at the lowest cost, then we should satisfy ourselves that our plant is in good order, and that we understand how to operate it to the best advantage. We must know thoroughly the various factors which influence its output. The time for studying these factors and getting to know the full working capabilities of the carburetted water gas plants installed by gas undertakings throughout the country is now. They should with the next few months be given trial runs to ascertain what modifications, if any, are needed to make them operate at maximum capacity. Trial runs on the lines suggested might in very many cases prove an eye-opener. They might show that what was previously considered to be the maximum output of a plant was, with more skilled control, far short of the mark. At any rate we think that as yet the flexibility of water gas plant has not been put to full use by the Gas Industry.

Much extremely valuable research work has been undertaken on the operation of water gas plant, but we doubt whether the findings have generally been translated into practice. We know they have by some undertakings, but we are thinking of the Gas Industry as a whole. We have in mind particularly the 35th and the 37th Reports of the Joint Committee of the Institution and Leeds University, which contain a mine of practical advice based on the soundest of technical investigation, for which the Industry has paid. Has that advice, in general, been acted upon? We suggest that gas engineers should refresh their minds with the contents of these reports, which contain information which has a direct bearing on the sale of fourpenny gas, for a large proportion of the future peak loads of the Industry will obviously have to be sold at low rates.

We quote the following from the 37th Report: " The charges for capital and labour are so important that, when

using carburetted water gas as a coal gas auxiliary, the total costs of manufacture per therm of carburetted water gas of a given calorific value are a minimum when a plant is operated at a high output. To obtain the high output, (a) the blast pressure should be such that, with the temperatures in the fuel bed at the maximum allowed by clinker formation and wear and tear of the generator, the heat in the blow gases is no more than is required for carburetting; (b) the rate of steam supply during the run period should be as high as consideration for the quality of the blue water gas will permit, unless the rate of oil supply then required leads to excessive loss of oil efficiency. With the rates of air and steam supply thus determined, the relative durations of the run and blow periods are fixed by the necessity of storing sufficient heat in the fuel bed during the blow to decompose the steam during the run. The procedure outlined above depends upon the fuel bed being of adequate density to withstand the blast pressure required to control the heat in the blow gases."

We make no apology for this lengthy quotation. The points made in it are of great importance at the present juncture. The output of a carburetted water gas plant is proportional to the percentage of the blow period in the cycle. A high rate of steaming is needed, and it should be ascertained that valves are of adequate capacity to pass the amount of steam required for maximum output. The coke should be well screened. The plant should offer a minimum resistance to gas passage, which means that attention must be paid to the wash box, the mains, and the purifiers. The wash box and overflows should be cleaned from pitchy deposits, and it is advisable, to prevent blockage, to spray water into the gas leaving the superheater.

It must be remembered that the amount of heat required for carburetting depends on the efficiency with which the potential heat of the blow gases is utilized in maintaining the temperature of the carburettor and superheater. The efficiency of using the heat in the blow gases depends upon supplying the secondary air, first, so that its amount is always equivalent to the carbon monoxide in the blow gases, and secondly in such a way that it is rapidly admixed with the blow gases in order to liberate most of the heat at the top of the carburettor, where the greatest absorption of heat from the chequerwork occurs during the run period. In the more recent plant secondary air is injected through a number of ports in the generator-carburettor main.

All the foregoing points should have the closest consideration, but, as we have said, existing plant must be tried out to discover of what it is in fact capable under skilled technical control. In our opinion the adequate staffing of water gas plant has in many cases been allowed to slide. This deficiency should be remedied, for trained operators are needed if the best results from the working of water gas plant are to be obtained. We have no doubt at all that the general standard of this working could be improved.

Civil Defence

In the Editorial Note on Civil Defence contained in our issue of Aug. 16, the impression was unfortunately given that in a vulnerable area undertakers would have to make a report as to the measures to be taken to ensure continuity of supply, although the Board of Trade had not served upon them any notice requiring such a report. We hope that this has not given rise to confusion.

The true position is that undertakers in vulnerable areas are under an obligation before Oct. 13 to make a report as to the provision of air raid shelters whether or not they have received notice so to do from the Board of Trade. There would, however, be no similar obligation with regard to the report in connexion with the measures to ensure the continuity of supply.

Air Conditioning

Referring to air conditioning recently in the "JOURNAL" we remarked that it is a highly complex subject, and one to which considerable expert attention must be devoted if the Gas Industry is to secure any considerable part of the load that appears likely to develop from this movement. In America, of course, climatic conditions favour air conditioning more than they do in this country. Nevertheless there is a field here, if not in the modest home, at least in commercial premises and in places of entertainment, quite apart from industries where atmosphere control is either essential or desirable for the carrying-out of particular processes. Discussing the question in a recent Paper—see later pages—Mr. C. R. Bellamy stated that in the States the thousands of air-conditioning installations in department stores, restaurants, theatres, and other commercial establishments have yielded such good returns to their investors that competitors will be faced with either to fall in line or suffer. But air-conditioning equipment does not sell itself. It represents a specialized load and has to be sold, and if the Industry believes in the practice of air conditioning one of the first steps should be to air-condition gas showrooms, thereby not only making consumers comfortable but giving a practical demonstration of its value. A further step would be for the larger undertakings to establish a special department for dealing with the business, with a trained engineer at the head. Admittedly we are looking ahead, and we realize that substantial development will cost money in planning and propaganda. The problem does, however, merit attention, and it is good publicity that gas should be used for this new service.

In the event of hostilities the Address of the "Gas Journal" Offices will be:

CLUNY LODGE, SANDOWN AVENUE, ESHER, SURREY.

Telephone No. Esher 747

Personal

At a meeting of Leslie Gas Company, on Aug. 23, Provost H. PATERSON was appointed Chairman in succession to the late James Ramsay.

Miss Margaret I. McGregor, daughter of Mr. R. H. MCGREGOR, Engineer, Manager, and Secretary of the Coalville Urban District Council Gas Department, and Mrs. McGregor, was married to Mr. JOHN DEACON GUY, of Hugglescote, at Whitwick Parish Church, on Aug. 21.

Mr. A. P. ADEANE has been elected Chairman of Cochran & Co. (Annan), Ltd., to fill the vacancy created by the death of Mr. C. E. CROMPTON.

Among wills recently published is that of Mr. HORACE M. THORNTON, Chairman of Richmond Gas Stove Company (Radiation Ltd.), and other companies, who left £68,235 (net personalty £29,065).

News of the Week

The Annual Dinner of the Coke Oven Managers' Association is to be held at the Hotel Victoria, Northumberland Avenue, London, W.C.2, on Thursday, Oct. 26.

The Board of Trade have approved the Darlington Gas Order giving the Darlington Corporation power to supply areas in the Darlington, Sedgefield, and Barnard Castle rural areas.

A Change of Address is announced by the Institute of Fuel. In view of the present emergency, it has been considered advisable to remove the more important Institute records to a country district. Accommodation has, therefore, been obtained at a small Private Hotel, Stangrave Hall, Godstone, Surrey, and the affairs of the Institute are being conducted from there instead of from London until further notice. If possible, a telephone will be installed for the exclusive use of the Institute, but meantime there is one line serving the Hotel for the general use of all residents. Telephone number "Godstone, Surrey, 101."

A Carbon-Monoxide Indicator has been marketed by the Mine Safety Appliances Company, Pittsburgh—a portable hand-operated indicator sensitive to concentrations as low as a few thousandths of 1%. A small four-cylinder radial hand-operated pump develops suction for sampling, and a built-in pressure regulator automatically maintains a correct sample flow, indicated on diaphragm-type pressure gauge. The percentage of carbon-monoxide is indicated on a direct-reading calibrated meter having scale range from 0 to 0.15% carbon-monoxide. The meter can be read directly to 0.005% and readings estimated to 0.001% (one part in 100,000).

Progress in the Use of Gas is always plainly evident on the stands at the Leipzig Fair, and at this year's Autumn Building Fair, which will be held from Aug. 27 to 31, and supported by some 350 exhibitors, those interested in such things will again be able to see a number of new gas appliances for use in kitchens of the larger type, such as a large capacity hot plate with gills or fins for collecting heat. New methods of using gas for washing purposes and bathroom equipment will also be shown, while such exhibits as the new small water heaters for the home, especially in smaller houses, "eco-boilers" which use surprisingly little gas, and a small gas-operated refrigerator of about 2 cu.ft. capacity costing very little to run will sure to be particularly interesting to visitors to the Fair. There is also a very economical gas iron which uses only some 4¼ to 5 cu.ft. per hour. A new section at this Fair will be that devoted to the uses of propane in houses where there is no mains supply, and appliances of every kind for this use will be on view. The Gas Exhibition has been arranged by the Central Organization of Germany for the Use of Gas and Water in Berlin.

The Kirkham Gas Company give notice of their intention to apply to the Board of Trade for an Order under Section 1 of the Gas Undertakings Act, 1929, to enable the Company to borrow on mortgage or by the issue of debentures and to modify the provisions of Section 8 of the Kirkham Gas Order, 1881.

The Unofficial Strike at the Higham Works of Cellactite and British Uralite, Ltd., in Kent, is now at an end, the strikers, with few exceptions, having returned to work unconditionally. The strike was never more than partial, the majority of the Company's employees having taken no part in it. The Works are, of course, now in full operation again.

The New Session of the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3, which extends over about 36 weeks, will begin on Monday, Sept. 25, and students will be enrolled on and after Sept. 20. The Institute provides evening instruction in many subjects, including fuel technology (embracing coal carbonization and gas engineering) and chemical engineering.

A Simple Structure (painted dead black) enabling shopkeepers to keep their premises open during all emergencies, and complying with Government Regulation regarding artificial lighting, has been standardized by the British Standards Institution on the authority of the Home Office. Full particulars will be found in the Specification, which can be obtained from the British Standards Institution, 28, Victoria Street, Westminster, S.W.1, price 3d. per copy.

A General Discussion on "The Properties and Testing of Heat-Insulating Materials," organized by the Joint Committee on Materials and their Testing, in conjunction with The Institution of Gas Engineers, will be held in London on Nov. 23 next. The sub-divisions of the subject and the names of the Authors who are contributing Papers are as follows: (1).—*High-temperature Insulating Material:* British Refractories Research Association (Great Britain); Dr. J. B. Austin, United States Steel Corporation (United States). (2).—*Low-temperature Insulating Material:* Dr. Ezer Griffiths, F.R.S., National Physical Laboratory (Great Britain); a Paper from an authority in the United States. (3).—*Insulation of Buildings:* A. F. Dufton, Building Research Station (Great Britain); Professor F. B. Rowley, University of Minnesota (United States). (4).—*Mechanical Engineering Applications of Insulation:* J. S. F. Gard, Washington Chemical Company (Great Britain); Cope and Kinney, Detroit Edison Company (United States). In addition, Professor M. P. Brémond, of the Manufacture Nationale de Sèvres, France, will review the position of heat-insulating materials on the Continent, while Professor E. A. Allcut, of the University of Toronto, will deal with the subject from the Canadian point of view.

Forthcoming Engagements

Sept.

5.—**I.G.E.**—Sub-Committee on Processes Involving Flames or Glare of the Gas-Works Safety Rules Committee.
6.—**L.C.C.A.**—Advertising Sub-Committee, 2.45 p.m.
7.—**North British Association.**—Annual General Meeting, United College Hall, the University, St. Andrews.
8.—**L.C.C.A.**—Coke Distributors' Branch Central Committee, 2.30 p.m.
11.—**I.G.E.**—Research Executive Committee, 2.30 p.m.
12.—**I.G.E.**—Finance Committee, 10 a.m.; Membership Committee, 11 a.m.; Council, Gas Research Board, 11.15 a.m.
12.—**N.G.C.**—Central Executive Board, 3 p.m.
13.—**I.G.E.**—Pipes Committee, 2.30 p.m.
18.—**L.C.C.A.**—Finance Committee, 10.45 a.m.; Executive Committee, 11.15 a.m.; Central Committee, 2.30 p.m.
19.—**I.G.E.**—Gas Education Executive Committee, 11 a.m.; Gas Education Committee, 2.30 p.m.; Gas-Works Safety Rules Committee, 2.30 p.m.
19.—**L.C.C.A.**—Technical Committee, 2.30 p.m.
21.—**S.B.G.I.**—Council Meeting, 11.15 a.m.
21.—**I.G.E.**—Refractory Materials Joint Committee, 2.30 p.m. (at Stoke-on-Trent).
21.—**Wales and Mon. Association.**—General Meeting at Porthcawl.
22.—**North of England Association.**—Autumn Meeting at Malton.
26.—**B.C.G.A.**—District Conference at Stroud.
29.—**I.G.E.**—Liquor Effluents and Ammonia Committee, 11.30 a.m.; Joint Research Committee, 2.30 p.m.

Oct.

3.—**I.G.E.**—Research Executive Committee, 2.30 p.m.
5.—**B.C.G.A.**—South Wales District Conference at Neath.
6.—**I.G.E.**—Joint Committee on Complete Gasification under Pressure, 14, Old Queen Street, S.W. 1, 3 p.m.

U.K. Gas Corporation

Increase in Gas Sales During Half-Year

A substantial increase in production is reported by the United Kingdom Gas Corporation for the first six months of this year as compared with the corresponding period last year. A total of 19,389,256 therms was distributed by the 52 gas undertakings directly controlled by the Corporation during the six-month period as compared with 17,904,806 therms in the first six months of 1938, representing a net increase of 8.29%.

During the month of June the amount of gas sent out was 2,861,876 therms, representing a net increase of 8.88% over the figure for June, 1938. Similar increases are reported in the number of gas appliances sold. In the first six months of this year, there was a net increase of no fewer than 22,301 major gas appliances fixed in consumers' premises.

The increase in gas sales is largely a result of the improved sales service and the favourable gas tariffs offered in the majority of the areas supplied by the Corporation's subsidiaries. The tariffs are designed to afford the consumer a charge for gas at which it can be used for room and water heating at a cost which does not exceed that of raw coal.

Effective A.R.P. Screen for Hurricane Lamps

Ordinary type of hurricane lamp with the South Suburban A.R.P. conical screen alongside.

At this time many gas undertakings will be considering how best they can shield the hurricane lamps which mark their road works at night so as to conform adequately with A.R.P. regulations. They must, moreover, visualize the necessity for some simple adaptation which can be applied at a reasonable cost and at short notice to all their standard hurricane lamps—of which they will doubtless have an ample margin for emergency requirements.

Here is the lamp fitted with plain glass globe to enable screen to be seen in position

IT will be a matter of some considerable interest to the Industry to learn of a device which has been patented by the South Suburban Gas Company and Mr. F. T. Buist, A.M.I.Mech.E. (Assistant Distributing Engineer to the Company), the latter having designed it.

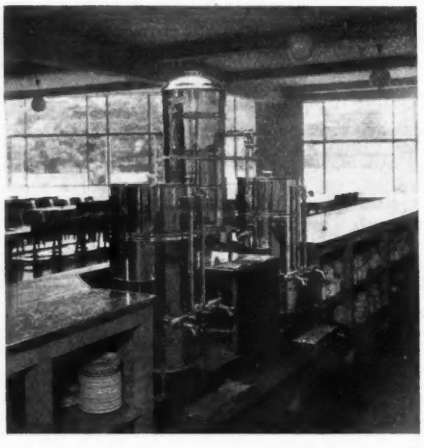
For the more common circular type of hurricane lamp, the device—which is made of tin—consists first of a circular plate with a hole to fit over the wick guard in the centre. This rests on top of the perforated plate which normally supports the red glass globe, thereby preventing any downward rays of white light on to the road surface. The plate is designed so as not to interrupt the access of air necessary for the combustion of the lamp.

On this plate rests a conical screen of the same material—measuring about 6½ in. high, the base diameter of 3¼ in. tapering to 1¼ in. at the top. Approximately half-way up this cone there extends horizontally around the circumference a shield about ½ in. wide, and immediately below this are punched a series of holes right round the cone. The object of this is to exclude light above the horizontal—and when the lamps are hung, as they usually are, on poles or trestles some 3 ft. or so from the ground the light is clearly visible to both motorist and pedestrian—but totally invisible from above. The size of the holes within certain limits, in accordance with the amount of light required. The ordinary red glass globe fits naturally in the cone can, of course, be varied, over the screen, which in no way interferes with the normal functioning of the lamp.

Screen for square type lamp.

For the square type lantern now used to quite a considerable extent a device embodying similar principles has been adopted. In this case the shield consists simply of a three-sided sheet of tinplate with the holes punched through about half-way up. As these square lanterns are fitted with "bull's eye" lenses, there is no necessity for a shield above the holes, for the design of the glass is in itself sufficient to preclude any material escape of light above the horizontal. In each instance the appearance of the lamp at night is that of a narrow red line—fully visible at eye level, but little higher. Our illustrations are sufficient in themselves to emphasize the extreme simplicity of this A.R.P. screen—which for the same reason is very reasonable in cost.

The device is practical, effective, and readily adaptable, as we have shown, to any standard hurricane lamp. Mr. Buist is to be congratulated upon this useful development, while the South Suburban Gas Company have rendered a signal service in making the details known for the benefit of all at this anxious time.



A Gas Canteen Installation

Here is [the latest canteen installation by James Stott & Co. (Engineers) Ltd. This photograph does not do justice to the whole of the equipment, as it only shows the tea-making battery. The firm actually were responsible for supplying the following equipment: Double compartment pressureless type steaming oven; two pan fish-frying range; griller and stand; four-oven cooking range, part open and part solid top; automatic dish washing machine; numerous vegetable preparation sinks, and tea-making battery as shown in the photograph. The latter comprises an instantaneous and continuous gas heated water boiler used in conjunction with tea-making urns, each urn being fitted with water jacket, and gauge glass, gas-heated base, and inner linings of pure nickel. In addition to the above equipment were hot cupboards and carving tables installed in a long service counter.

Space Heating by Gas

By E. HEMINGWAY JONES

From a Paper to the East Midlands Branch of the Institution of Heating and Ventilating Engineers

After discussing comfort conditions, heat requirements, and describing low-pressure and high-pressure overhead gas heating systems, the author went on to say:

There are many who say that conversions are a mistake. I can only refute this by saying that it has brought us considerable business and that many of our installations are working very satisfactorily in their fifth heating season in some cases in boilers over 20 years old. The fact that consumers do not wish to be tied up to a specially designed boiler, but one on which an alternative fuel could be used at short notice led us to experiment. We now invariably recommend a standard conversion for reason that it can be dismantled within half-an-hour if necessary, but we do not object to any other system if it is specially called for.

There are two types of conversion in particular use, firstly those which rely on flame contact with the metal for heat transmission, and secondly, those which utilize radiant heat from a refractory bed or fire-brick lining.

Examination of both types of conversion shows that they have approximately the same percentage of efficiency of running except on the smaller type of boiler. It is a general rule that efficiencies are not so high on the smaller type of boiler. I have not come across a conversion of the second type in a small boiler and so I cannot speak of this practically.

The combustion space in an ordinary boiler is limited and it is necessary to burn a relatively large quantity of gas in a small space without the ingress of excess air which would only serve to cool the products of combustion.

This should be carried out without the adventitious aid of chimney draught. As thermostatic control must necessarily be employed, bunsen burners cannot be used satisfactorily owing to the risk of back-firing. Bunsen burners also have the fault that they usually inject more air than is required for combustion.

When brickwork is built into the boiler to act as a lining it is usual for the combustion to take place at jets, the flames being allowed to impinge on the brickwork or a bed of broken refractory. The time of heating up of a boiler arranged like this is slower than in the next type, and one never knows what is happening at the back of the refractory. One experience we had with a boiler of this type was that the brickwork collapsed after twelve months and necessitated the re-bricking of the boiler, while in another instance the bricklayer who was of no mean girth was nearly unable to brick up the boiler owing to his inability to reach the back. When the boiler is not fitted with brickwork it is advisable to have the flames playing on to the ironwork as the turbulence produced induces a rapid heat transmission from the flame to the metal work, and so to the water. It is not customary for more than ten minutes to elapse from the time of lighting the boiler to the commencement of circulation of hot water, and in many instances this time is very much less.

The type of burner usual in these conversions is the Duoflam, or, as it is known in America, the Barber burner. The burner itself comprises a semi-bunsen burner—*i.e.*, it is a brass tube complete with jet which also contains two small holes for admission of some primary air. To promote turbulence and procure combustion in a minimum space the jets on the burner bars are always arranged in pairs so that the flames meet one another at an angle of about 120°. This causes the flame to spread out in a fishtail which effects combustion very rapidly. These burners have proved very effective and up to date we have not had to replace a single one out of the thousands in use in Derby. The fitting of these burners is extremely simple if one follows the instructions, but for the final setting of the installation it is necessary to have scientific control. This is effected by checking the composition and temperature of the flue gases. It is a simple matter to leave an installation of this nature adjusted so badly that the boiler efficiency is only about 20%, if proper supervision is not given.

All installations of this type must have effective thermostatic control if they are to be economical, but as control is a subject on its own and capable of many adaptations, I will discuss this later in my paper.

Another type of installation I should like to mention here is one which has made its debut in America but has not I believe yet come to this country.

This is a calorifier system of heating which is most unusual and is about 95% efficient. The whole of the products are utilized and the condensed water from the products of combustion are returned to the boiler, any surplus being allowed to run to waste. The draught necessary for the combustion of the gas is maintained by an electric fan and upon lighting up the installation the heat travels along the pipes as fast as one can walk. Combined with the boiler in one unit is also an air-conditioning system which makes it a very compact heat arrangement.

Before leaving the subject of water heating I should like to make mention of the heating of calorifier systems by gas. These systems have not been considered readily adaptable to gas until recently owing to the difficulty of controlling them thermostatically, but we have now developed two schemes whereby they can be completely controlled by thermostats or by a combination of thermostat and manual control. The former is expensive but renders the system free from all manual control.

Flues

Difficulties have frequently arisen with gas apparatus owing to the fact that steam is produced when gas is burned. The dew-point when combustion is just complete without excess air is 167° F. Excess air is usually present and the dew-point therefore correspondingly reduced. The products of combustion passing up the chimney may become stratified and the outside layers be cooled below the dew-point, although the main products are much above. The result in this case is the same as though all the moisture had been condensed—*i.e.*, wet patches appear on the walls of the higher rooms.

There are two methods of overcoming this difficulty dependent upon the conditions under which the boiler is to be fixed. These methods depend upon either catering for condensation or eliminating it by adding sufficient air to carry all the moisture. The latter method is the most economical and useful and merely consists of removing the soot door from the existing chimney if connexions are made thereto. In other cases it may be necessary to line the chimney with glazed bricks or with glazed earthenware pipe and make provision for the removal of the condensate. Individual consideration of each particular case is desired but very rarely is it necessary to make arrangements for the removal of condensation.

Air Heating

Air heating and conditioning particularly on the small scale has not developed rapidly in England, although many more schemes are coming forward during this season than formerly. In my opinion this form of heating will develop although it is doubtful whether it will ever displace the hot-water radiator in domestic premises.

In workshops and large buildings it is already a *fait accompli* and would, I think, be more popular were it possible to adapt existing buildings more readily. It has the big advantage that it can be put into operation much more quickly than a hot-water system, and is much more flexible. Gas is being used as the fuel in many instances for either large or small systems.

Home heating units are greatly used in America where one heater placed in the hall warms the whole house. This is possible for instead of solid doors, curtains and archways are used. The whole of the products of combustion are sent into the air, which creates the necessary humidity in a dry atmosphere and any deleterious effects are overcome by the incorporation in the unit of an ozonator. This ozonizer or ozonator has a remarkable invigorating effect and although not essential for the operation of the apparatus is a very beneficial adjunct.

Several firms are making heaters of this type, which are becoming popular in small and large workshops.

The domestic apparatus and industrial apparatus, although differing largely in appearance, operate upon the same principle, the gas is burned to completion and the products together with a large excess of warmed air are circulated through the building by means of an electric fan. Louvres are fitted so that the air stream may be directed where required. One advantage of heaters of this type is that the amount of ground space occupied is small—*e.g.*, the domestic apparatus resembles a radiogram, and the workshop type is suspended from the ceiling. All heaters are replete with the latest thermostatic controls which in one case render it absolutely foolproof. The heater cannot operate if the by-pass is extinguished or not lighted, air thermostat control regulates it according to the required temperature, and if the electricity to the fan fails then the gas supply shuts down. The fans also can be obtained so silent that at a distance of 2 to 3 ft. they cannot be heard running. The temperature of discharge of air into the atmosphere is capable of regulation by adjustments of the gas cocks, and it is not considered advisable to heat the air unless desired for process work much above 85° F.

The heaters are made in sizes up to 100,000 B.Th.U. per hour, and as 1 B.Th.U. is capable of heating 50 cu.ft. of air 1° F. the volume of circulating air can be readily calculated.

In large-scale plant, conditioning of the air may be attempted for public halls, buildings, and process work, but is rarely attempted in workshops. The principles of humidifying and cleaning of recirculated air do not come within the scope of this paper, but can be applied to the large-scale plant with direct or indirect heating with equal facility. The other factor of ducting which is the bugbear of installation in existing buildings need not be mentioned now.

The principle of indirect heat may be either by hot-water boilers or by steam boilers. Steam boilers make the plant more flexible when steam has been raised and the transmission of heat is very effectual and rapid.

The amount of heat required by any of the foregoing systems not employing radiant heat is the same as that required by any system, although air-circulating systems have in practical application a slight advantage.

It may be of interest at this point to consider shortly a method of estimating the running cost of gas-heated installations, for it is on this point that gas perhaps has the greatest interest to the majority of consumers. I do not intend to introduce the ancillary selling points which may have a strong bearing in certain cases where labour can be saved.

The points to be considered are:

(1) The hourly heat loss of the building to maintain a definite temperature.
(2) The efficiency of operation of the boiler.
(3) The hours the boiler will be in use during the day.
(4) The days per week it will be in use.
(5) The number of weeks the boiler will be in use during a normal heat season.
(6) A factor which has been determined from practical experience.

This formula now becomes:

$$\frac{\text{Net heat requirements, in B.Th.U./hour}}{100{,}000} \times \text{hours/day} \times \text{days/week} \times \frac{6}{10} \times \frac{100}{80} \times 30$$

and gives the therms required for a 30-week season. It must be remembered that heating with gas-fired boilers is very seldom carried on for 24 hours per day, and very approximately it may be reckoned that with gas at 5d. per therm and coal at 35s. per ton for eight hours' heating the cost is comparable; for 16 hours double, and for 24 hours approximately three times.

Wood Gas

Interesting French Research Work

The Gas Industry is so accustomed to thinking in terms of coal gas that it is a little difficult to realize that there could be gas-works that manufacture and distribute wood gas, and that the production of wood gas brings with it problems differing considerably from those of coal gas. A paper presented by Messrs. Larguier and Lemaire to the French Inter-regional Gas Congress of the South Eastern Area calls attention to the possibilities in certain parts of the world of manufacturing wood gas. The authors point out that there are, for example, many small French gas-works, of which about one hundred are situated in forest country, to which a process for the production of wood gas would be of interest. It would be difficult to imagine the manufacture of gas from wood in this country, but there are parts of the Empire where the process might prove attractive. As an example of the gases generated from wood, reference may be made to the work of Vincent, who found that by straight distillation at 1,000° C. the resulting gas contained 20% of CO_2, 30% of CO, 40% of hydrogen, 8% of methane, and 2% of heavy hydrocarbons. There were also evolved 40% of water and 8% of wood tar, while 25% of charcoal remained in the retort. The problem facing the gas maker is to increase the quantity of gas produced and to increase its calorific value by removal of carbon dioxide.

The Riché retort, which has been in existence for some 40 years, enables the quantity of gas produced per ton of wood to be doubled by utilizing secondary reactions. This retort consists of vertical tubes a foot in diameter and 9 ft. in height closed at the top by a lid so that the gas escapes from the bottom. The retorts, filled to a height of about 6½ to 7 ft. with charcoal, are heated to a bright red heat and charged at the top with 20 or 25 lb. per hour of fresh wood. The products of distillation pass downwards through the incandescent carbon, and a purified gas is obtained consisting of 18% CO_2, 22% CO, 15% CH_4, and 45% hydrogen, the calorific value being some 350 B.Th.U. per cu.ft. and the yield 25,000 to 27,500 cu.ft. per ton of wood with a residue of some 410 to 460 lb. of charcoal.

It would be quite possible to remove carbon dioxide from this gas by washing it with water under pressure, thereby raising its C.V. to over 425 B.Th.U. per cu.ft., a value which would be quite sufficient for town purposes, since many gas-works operate upon a declared C.V. in this region. It would also be possible, if desired, to enrich this gas with hydrocarbon oils.

Reduction of Carbon Monoxide

The authors of the paper, however, take the view that the carbon monoxide content of the gas must also be reduced, and discuss means whereby this can be done. They reject the absorption of the carbon monoxide in ammoniacal cuprous chloride and also the formation of sodium formate by the action of soda lime, since both methods simply remove a useful constituent from the gas at considerable expense while putting nothing of value back in its place. The use of lime at 500° C., however, is free from these objections, since according to the reaction: $CaO+CO+H_2O=CaCO_3+H_2$, the carbon monoxide is replaced by an equal volume of hydrogen so that the calorific value can be maintained undiminished. A similar process, the Vignon process, also makes use of lime, but uses the reaction: $4CO+2Ca(OH)_2+CaO=CaCO_3+CH_4$, and is said to produce a gas having a C.V. up to 530 B.Th.U. per cu.ft. These processes which involved the use of lime, however, necessitate an increase in costs of 19-20 centimes per cub.m. (at par, 13d. per 1,000 cu.ft.).

The authors finally propose the use of the reaction between carbon monoxide and steam: $CO+H_2O=CO_2+H_2$. The gas leaving the Riché retort is freed from CO_2 by washing under pressure and is then re-heated and with addition of steam is passed over a catalyst consisting of limonite with 5% of potassium carbonate hardened with cement. The carbon monoxide is thus replaced by hydrogen, and after again removing the CO_2 a finished product is obtained containing 6% of carbon monoxide and having a calorific value of about 425 B.Th.U. per cu.ft. The fuel consumption of the distillation process is such that as much wood is needed to heat the retort as is distilled in the retort.

A process of this character would, of course, be of no immediate interest in this country. It is possible, however, that it might be of use in peculiar local circumstances as a means of utilizing wood waste, or if coal happened to be expensive or unprocurable while wood was available it might be considered on small works. It would not seem in British practice to be necessary to take the trouble outlined by the authors to reduce the carbon monoxide content of the gas, but the paper is of considerable interest as showing the type of process that one might be driven to use in an emergency, and also as showing the methods that could be adopted to remove carbon monoxide, if it should be necessary.

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□ BIRKENHEAD	209	■ MELBOURNE Aust. (6th Instn.)	160
■ DONCASTER	193	■ PETERBOROUGH	133
■ EXMOUTH (2nd Installation)	36	■ TURIN (3rd Installation)	576
■ LISBON	177	□ WOLVERHAMPTON	137
■ WORCESTER	74		

W-D Intermittent Vertical Chambers

■ WESTON-SUPER-MARE (2nd Installation) - - - - 72

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T.G.S.

As Harold the Flaxen was walking by the seashore one day he came upon three warriors setting on a shipbuilder. On inquiring the reason he was told that the warriors had put to sea the week before in a ship made by this shipbuilder and it had capsized immediately, and they had been forced to swim ashore.
Harold asked to be shown this ship, and having seen it he said, "You, shipbuilder, have deceived these warriors by letting them go to sea in a poorly built ship. But you three who capsized were much to blame. You had not inquired into this man's Honour nor his Reputation. Besides this, you did not assure yourselves of his Skill, his Reliability, nor his Knowledge of his Craft."

Illustration by Fortunino Matania, R.I.

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Management and Corrosion

Presented at the 32nd Annual Convention of the Canadian Gas Association, Hamilton.

By ERICK LARSON,
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The complexity of corrosion warrants its consideration as a distinct branch of science. Intimate conception of corrosion theory and practical application of protection requires specialization. The executive or managing engineer is interested in knowing how this scientific tool may be used and what are the criteria of its successful application.

A factor adverse to the establishment of a policy to protect against soil corrosion is that the success of protective practices is, on the average, not apparent in a decreased operating expense during the span of an individual's active participation in productive enterprises. The establishment of corrosion protective policies will, in most instances, only benefit future generations. Such circumstances make it difficult to secure authorizations for expenditures in excess of those required for the installation of unprotected pipe.

This very attitude, followed by previous managements, accounts for the repair and replacement costs of systems of buried metallic conductors progressively growing and at an ever increasing rate. This tendency will continue until the system as a whole has reached the average of its ultimate life and will then fluctuate, due to variation in the quantities installed in any unit of time. The curious part is that such high expense of replacement of capital is not the result of a lack of knowledge, 50 or 100 years ago, as to the inevitability of failure from corrosion or to methods of mitigation. Records indicate that the founders of the Gas Industry soon recognized the problem and, to a more limited extent than to-day, successful methods of mitigation. It was unwillingness to provide the additional capital outlay, not entirely a lack of knowledge, which has increased the loss from corrosion, which includes the cost attendant with loss of the commodity or material conveyed and the indirect effects resulting from such straying. There are many expenses incurred directly traceable to a single cause but, due to accounting methods, such expenses are seldom allocated directly to the cause. Corrosion, therefore, may be responsible for damage claims, injuries, legal expenses, and a proportion of general expenses.

Economic Studies

An argument not infrequently used in the Gas Industry against use of a corrosion protection is that the future of the Industry is problematical. It may be said without hesitation that while there may be fluctuations in popularity or use of the various commodities or material conveyed by sub-surface ducts to-day, they will always be used if maintained in a useful condition.

A study looking towards the establishment of a protection policy results in a reason for, or an alibi against, a favourable decision. The reasons for may be found not only in the science of corrosion but such intangible factors as safety, public convenience, goodwill, and reasonable continuity of service. The alibi is frequently substantiated by economics. Proper interpretation and the mitigation of the effects of corrosion in any individual condition require fully as much exercise of judgment as the solution of technical problems in every other phase of operations. Economic studies can be a valuable guide to judgment in the establishment of a policy. There are locations where estimates, reflecting experience and including all phases of the subject, do justify installing unprotected thin walled metallic ducts.

A decision to conduct a preliminary corrosion survey is based to a large degree on judgment. The long-term trend of maintenance costs may influence judgment, but the trend must be weighted by a general familiarity with the factors allocated to maintenance costs. The amount and trend of unaccounted-for gas, while important, is more difficult properly to interpret than costs, as a thorough knowledge of local conditions is necessary in order to assign the proper weight to the factors produced by corrosion.

The observations of workmen who have exposed mains and services may also aid in making a decision as to the necessity for ascertaining the deterioration caused by corrosion. The value of information obtained from workmen is of particular importance on a comparatively new system as other data, such as financial and engineering statistics, may not be indicative because complete penetration of the pipe wall had been infrequent or had not occurred at any point. It is not uncommon to find that the extent to which corrosion has progressed is not realized until a managing engineer or executive overhears a remark or perchance views a portion of an exposed main.

One or more of the above influences may indicate the desirability of securing some mathematical measure of the extent to which corrosion of the metals has progressed before its effect is reflected in operating statistics. The extent to which the survey shall be carried should be definitely established, as such surveys when assigned without restriction to capable engineers, frequently become extensive research programmes. Corrosion surveys easily become intriguing studies, and the extensiveness of the subject may lead the interested engineer far afield from the purpose originally intended. During the period devoted to a preliminary survey, frequent reports should be required from the field engineer to assure that prescribed imitations are followed. The reports should include the pit depth measurements taken wherever pipe or duct was exposed during the regular course of business, together with observations and comments of the field engineer. At first these measurements should be made by an engineer who will teach the gang foreman how to take measurements and what particular features to observe and report.

The engineer assigned to be responsible for the study of corrosion should personally make sufficient measurements to become thoroughly familiar with field conditions, as later the reports of foremen will occasionally require experienced interpretation. The corrosion engineer should eventually have personally made from 10 to 20 measurements in each square mile of distribution area. On transmission mains the corrosion engineer should personally make measurements in at least two locations in each type of soil, the type of soil being determined by surface indications.

Considering that measurements may be made where mains are exposed through excavation by others than a utility, the engineer would have measurements from two or three hundred locations in the course of the first month. Providing the locations are representative of the whole territory a month or two months of such field effort would provide sufficient data to determine the necessity for intensive surveying.

Preliminary Reports

When making up preliminary reports the engineer should include and comment on such statistical data, pertinent to the question, as are available. Should the decision be adverse to conducting an intensive investigation, the engineer making the preliminary survey should be assigned to assemble the data which are continued to be collected by the foreman and occasionally to go out with crews to enlighten them further on findings and for personal observation.

Should the preliminary survey disclose that the effects of corrosion have been more extensive than it was generally supposed, the next step would not necessarily be instigation of a complete corrosion survey. An intermediate step would be to expand the quantity of information being secured by the employment of additional technical help, or by increasing the volume of data obtained from the street or line crews. The engineer who originated the survey would then study the most effective way of securing data beyond that obtainable through the previously mentioned methods.

One of the first steps in extending the study would be to ascertain the number of soil types existing in a particular territory. At first this may be done by surface observation and if such methods proved inadequate or unsatisfactory they could then be extended to include such field or laboratory methods as would provide a detailed knowledge of the soil types. A

knowledge of the soil types would then outline the areas in which it may be of advantage to extend the intensiveness of the survey to include both field and laboratory determinations of the corrosiveness of the particular soils. A decision to make such an intensive survey would be influenced by the number of highly corrosive soil types found in the particular area, or by the number of replacements due to leakage, indicated by engineering statistics. The extent to which the study would next progress might well be limited to areas of highly corrosive soils, as indicated by locations of most rapid rate of penetration or of the greatest concentration of leaks.

The entire survey to this point has been merely to ascertain the intensiveness and extensiveness of the effects of corrosion. At this point it would become necessary to investigate the desirability of using various forms of protection.

The establishment of a protection policy which will require considerable investment above present unit main costs and the extending of such increased costs over a long period of years, require a strong conviction on the part of those responsible for the establishment of policies. The lower operating costs secured by adequate protection will ordinarily not be noticeable for a number of years.

It has been generally conceded among corrosion authorities that unless the best quality of protection is applied, by which is meant not only a waterproofing agency, but some form of wrapper to protect the waterproofing agent against physical forces, the decision may just as well be to use no coating at all. Regardless of the fact that numerous concerns still follow the policy of grading corrosion protection, there is considerable expert opinion that the effectiveness of a coating cannot be graded.

Some persons advocate installing bare pipe in all except extremely corrosive soils and later exposing and protecting sections found to be subject to rapid penetration. Such a practice is impractical on distribution systems and the experiences of many transmission line operators have indicated the practice to be uneconomical. The only places where conduits may be installed without protection with any degree of assurance is where a thorough survey on existing lines proves a lack of any material corrosion.

The time required to study the amount of available material and data on corrosion, in order authoritatively to pass upon the technical phases of a protection policy, is beyond the limits of time available to either executives or management. It cannot be too strongly urged at this point that the costs of protecting sub-surface conduits and pipe is only justified when the finest quality of protection is used, regardless of the opinionated policies in many firms.

Use of Alloys.

The subject of protection also brings in the question of the use of cast iron, alloys, and other corrosion-resisting materials, such as copper and aluminium. The permanency of cast iron has been established in certain local circumstances beyond question. The advisability of using cast iron is a matter which may be ascertained by economic studies. It is a matter of record that cast iron has not always the permanency commonly ascribed to it. There are a number of installations of cast-iron mains, several of which are recent, on which a corrosion protection has been applied. The use of copper has passed beyond the experimental stage, having been used principally by the water industry over a long period of years. In practically every territory one or more of the utilities have had experience with copper pipe. However, when lightweight tubing is considered for gas or water mans or services, the many mechanical difficulties encountered, in addition to the corrosion-resisting qualities, should be given consideration. There are local conditions that might produce a very rapid penetration of metals other than those of a ferrous nature. No one metal is a panacea for corrosion difficulties, and before any new material is substituted for one on which there is a long experience record, the many factors other than corrosion should be given consideration.

The use of alloys has potentialities for the future, but the rather high cost of such tubing or pipe material to-day precludes general use. It is desirable for all companies to experiment with the use of alloys so that, should the future decrease their cost, experience will be available to determine their practicability for any particular application.

There has been considerable publicity on certain types of conduits in which the basic material is asbestos cemented together with various binding materials. There has been considerably more experience in foreign countries, particularly Italy, on this type of pipe, but its use on this continent has been experimental. Factors to consider are its lower structural strength compared with metallic pipe and the difficulties encountered in making tight connexions. As with alloys, it is advisable for all companies to make experimental installations for the purpose of securing experience.

To sum up the question of the types of metals, it is generally conceded that considering all uses, the mileage of steel being placed in the ground exceeds that of cast iron and that steel possesses certain structural advantages over the more rigid cast iron. However, the advantages are not inherent in the form of the metal but rather in the methods used in constructing and maintaining mains and in the design of cast iron pipe. With certain radical changes in cast iron pipe installation practices a cast iron distribution system or even transmission main will be as satisfactory as steel. Such a topic is foreign to the subject of our present discussion.

One of the most difficult phases of corrosion to discuss is when a protection should or should not be applied. A preliminary report would indicate, with a reasonable degree of accuracy, how rapid penetration was occurring and how generally the effects were distributed over a system. When the maximum rate is such as to result in any considerable quantity of penetrations within a period of twenty to twenty-five years, judgment would indicate that protection was desirable on any permanent system. The securing of additional data would then depend upon the necessity of supplying greater substantiation for support of the added expenditures required.

When the maximum rate of corrosion indicates that no considerable amount of failure, by which is meant complete penetration, would occur until after forty years, a decision to apply protection would seldom be justified by an economic study, including only those cost factors ordinarily allocated to corrosion. Decision on a policy then becomes a matter of judgment on the importance of such intangible factors as safety, comparative construction costs at present and in the future, changes which may affect the rate of corrosion, which are many, &c.

Obsolescence and inadequacy have led some to decide adversely on the applying of protection. Technical developments have made remote the possibility of such factors being of importance. Sub-surface conduits will always be used for some purpose if not that for which they were originally installed. The few instances where all need for such ducts would cease to exist are unusual. The gradual increase in pressures will materially decrease the influence of inadequacy. If the trend of protection policy has been accurately judged the future will see an adequate protection applied to all steel pipes buried in city or suburban streets, and much more generally applied to transmission mains than at present.

The question of how extensively protection should be applied is also a difficult one. The areas where the rate of corrosion makes corrosion protection advisable may be only a small proportion of the whole. An important factor to consider is that where a soil survey lacks any positive indication of a high rate of corrosion, it does not justify a conclusion of its non-existence. Another intangible consideration is the additional costs attendant with various standards of construction. The importance of limiting protection to certain areas is frequently lost on a distribution system when the quantity of main or services installed is compared with the whole system. These factors are advanced to indicate a desirability to establish a definite protection policy when there is any doubt in mind. It is preferable to lean towards the safe side.

Another difficult corrosion problem is the establishment of a policy in regard to an old unprotected system on which the expenses, due to the effects of corrosion, are a major item in over-all costs. On transmission lines it is not difficult to expose a line while it remains in service, protect it, and replace it at a cost frequently justified when total replacement would be necessary within a comparatively short period. Such a solution is impractical where the ducts are under paved city streets, or where the frequency of connexions makes it difficult to raise the pipe above the surface of the ground. There have been a few instances where distribution lines have

been exposed and a protection applied with the pipe remaining in the trench. However, where such exposure requires the breaking of improved highway surfaces it may be found that a more economical method is to double-main the section, thus requiring breaking only of the sidewalk surfaces. There has been no generally satisfactory solution of the problem of protecting mains already buried under city streets except that of substitution.

Rapid Development of Cathodic Protection.

The rapid development of cathodic protection offers possibilities on unprotected distribution or transmission lines. The operating cost on either type of line is rather high when the pipe was not originally protected by some type of material having electric insulating as well as waterproofing properties. However, in both instances, and with favourable local conditions, cathodic protection has been successfully applied to wholly unprotected lines. The successful application of cathodic protection in its present state of development requires that the design and supervision of the installation be done by an expert in that particular field. The difficulties of application to transmission lines are materially less than those in connexion with a distribution system.

Cathodic protection is not only useful where a line has been only partially or wholly unprotected, but is particularly valuable where the type of protection applied had insulating properties, but unavoidable accidents during construction or during the life of the pipe resulted in damage to the electrical insulating value of the coating. In such instances the operating cost of cathodic protection is practically negligible and the cost is merely the initial investment. Cathodic protection has made rapid strides in the past few years and occasionally offers a temporary means of protecting uncoated lines in very severe conditions until such time as financing of new lines may be arranged.

The optimism of the Gas Industry, as to its permanency, is plainly indicated in the rapid increase of protection policies which established the practice of 100% coating of all types of ducts installed beneath the surface, including services.

Latest Practices in Pipe-Line Construction

Presented at the 39th Annual Convention of the International Acetylene Association, Houston, Tex.

By W. B. POOR,
Engineer to the United Gas Pipe Line Company, Houston, Tex.

A review of the progress made in the pipe-line field during the last 12 to 18 months indicates three major phases of advancement:

1. Improvements in welding facilities with particular respect to new and improved tips and rod.
2. The field stress relieving of arc welds.
3. The development and widespread acceptance of "Wrinkle Bending."

Improvements in Welding

Of particular interest to the pipe-line operator should be the comparatively recent development of a new four-flame tip for bell-hole or position welding; a new six-flame tip for double-jointing pipe and for roll welds; and a new low alloy steel rod.

The four-flame welding tip, as the name suggests, consists of four separate flames or jets burning from a common head. Two small parallel flames are used to preheat the pipe ahead of the welding puddle, a third and larger flame preheats the welding rod, while the fourth flame accomplishes the actual welding. It is believed that this newly developed multi-flame tip is particularly adaptable to the making of position welds, and that in its design the objections found in previous multi-flame tips have been corrected.

Distribution of heat is far more efficient with this new tip. The relative position of the flames has been so designed that the only necessary movement of the blow-pipe is continually forward. The rod, however, must be manipulated slightly and in such a manner as to control the height and contour of the deposited metal, in order to obtain the desired bead. The speed obtained with this new tip on position welding is comparable to the speed obtained with the old type three-flame tip on a roll weld. No special technique is required for its use.

The six-flame welding tip is similar in design to the four-flame tip with the exception that it has two additional preheating flames. Four flames preheat the pipe, a fifth preheats the rod, and the sixth accomplishes the actual welding. Because of the greater and more effective application of the heat, the six-flame tip increases the welding speed on rolling welds, as compared with the speed obtained with the three-flame tip, from 35 to 70%, depending on the pipe size.

The development of the composition of welding rods has been aimed towards higher strength and greater ease of control in the welding operation. A new rod has recently been designed to give tensile strengths 10,000 to 12,000 lb. per sq. in. greater than rods previously used in pipe-line welding, and yet retains sufficient ductility to meet all normal requirements. This rod has been developed for use with the new four- and six-flame tips for the welding of high-carbon pipe. In addition to its greater strength, it is believed that this new rod offers considerable resistance to overheating in the molten state and solidifies more rapidly than most rods previously used. These qualities in the new rod make for easier control of the welding puddle and in turn considerably increases the rate of welding.

Field Stress-Relieving

A comparatively new application of oxy-acetylene blow-pipe which may assume considerable importance in the future is that of "stress-relieving" arc-welds in the field. Certain classes of arc welding, because of the extremely rapid heating and cooling of the metal tend to develop and hold high internal stresses in the weld itself. Where an installation is designed for extremely high pressures, subject to shock and vibration or a wide range of temperatures, good practice dictates that the weld be stress-relieved.

It has been found that certain types of this work can be effectively and economically stress-relieved in the field by an oxy-acetylene flame. A complete stress-relief will result from heating the metal to about 1,200° F. and varying amounts of relief take place at temperatures ranging downward from that point. Insufficient work has been done on this problem to date to give a final and conclusive picture, although several instances of its application have been entirely successful.

By far the most interesting development in recent years in the field of pipe-line construction is the development of the

practice of wrinkle bending. Wrinkle bending is a modification of the creased bend and corrugated tangent which has, for some years, been in use in the fabrication of steam power plant piping. By 1935 the application of the "creased bend" and "corrugated tangent" had reached sufficient usage that one of the major pipe fabricating companies that year published a pipe design manual devoted entirely to its design and use.

During the same year the wrinkle bending of large diameter thin wall pipe was applied to a low-pressure casinghead gas gathering system in the East Texas Field. Its application to pipe-line construction has rapidly gained momentum, until to-day its wide usage is acceptable construction on practically all major gas transmission lines constructed during the last 18 months.

The advantages of the wrinkle bend are many, and the saving in dollars to the pipe-line constructor is apparent, although sometimes difficult to enumerate in detail. The wrinkle bend may readily be applied on any sag bend, over bend or side bend, thereby replacing the conventional "cold" bend or "fire" bend that at one time was standard practice. Its use eliminates unwieldy equipment and a large portion of the high labour cost that was incurred by the "Bending Crew."

Wrinkle bending has the further advantage of overcoming one of the main objections of the pipe-line constructor to the use of light-wall, high-carbon pipe, since all types of bends may be made in the field, on such pipe, with the same degree of ease that such a bend may be made on mild steel pipe. On the other hand, cold bending of thin-wall high-carbon pipe is most unsatisfactory because of the fact that such pipe is inclined to spring, without taking a "set," to such a point that it will collapse.

The preparation of the wrinkle bend is comparatively simple and the procedure is essentially the same for all sizes of pipe. It consists in heating with regular oxy-acetylene blow-pipe one or more narrow bends of metal at right angles to the longitudinal axis of the pipe. The large capacity multi-flame blow-pipe, designed for heavy heating operations, is particularly adaptable to this work. On pipe under 6 in. in diameter one torch supplies sufficient heat to prepare the pipe for bending. On pipe 6 in. in diameter and larger, a more satisfactory bend is made with the use of two flames, and on sizes 10 in. and above, such practice is essential. The band of heat should be 2 to 3 in. wide at the point of bending and should extend equidistant from the point of bend until the heated band extends $\frac{1}{2}$ to $\frac{3}{4}$ the circumference of the pipe, tapering to a point at the termination of the heated area. The pipe should be heated to a bright red, at which temperature the "critical range" of the metal is reached and the pipe is not strained as in cold bending. At this point the pipe is bent by hand, tractor or bending rig, until the heated portion buckles sufficiently to give the pipe a predetermined offset bend.

Good practice would seem to indicate that a 5° bend per wrinkle is a maximum and that a 2° to 3° bend per wrinkle is better. The number of wrinkles indicated, therefore, is predetermined by the total degree of bend required. At no time during the process of making the bend, or afterward, should the pipe be artificially cooled or quenched. Should high-carbon pipe be artificially quenched, in all probability the bend or wrinkle will crack, due to sudden chilling of the metal. If possible, the spacing of the wrinkles should be at least one pipe diameter apart. This is, however, not mandatory, as 24 in. Grade "B" Seamless pipe, having a wall thickness of $\frac{5}{16}$ in., has been successfully bent approximately 28° with 5° wrinkles spaced 8 in. on centre. Such practice should be followed only in special cases.

Actual Experiences

A review of some actual experiences in the application of wrinkle bending may, at this time, be of interest. On a recently constructed section of 18-in. main line, on which Grade "B" Seamless pipe was used, the regular or long radius bending was first attempted. A great deal of difficulty was incurred in bending the high-carbon pipe by conventional methods, as extremely long sweeps were required necessitating careful grading of the ditches and excessive excavation. With even these precautions several of the bends failed by buckling before the desired curvature was reached. Wrinkle bending was then resorted to with a result that the work was speeded up, construction costs were lowered, and no bend failures occurred.

A comparison of the two types of "Bend Crews" follows:

Regular or Long Radius Bending Crew.

Personnel: 1 Foreman; 1 Truck Driver; 1 Air Compressor Operator; 10 Labourers.
Equipment: 1 Air Compressor; 2 Johnson Burners; 1 Trunk (carry tackle kerosene, &c.). Bending block and miscellaneous tackle.

Wrinkle Bending Crew.

Personnel: 1 Foreman; 1 Welder and helper with acetylene torch; 1 Tractor Driver; 2 Labourers.
Equipment: 1 Tractor; 1 Sled attached to tractor to carry acetylene torches, and the like.

A comparison of the two crews indicates that a tractor was substituted for a truck, the air compressor and Johnson burners and heavy bending equipment were eliminated, and the crew personnel was reduced from 13 to 6.

Under both methods of bending, the work was done after the pipe had been welded into 120 to 160 ft. sections. While the number of bends per crew per day is not constant, and is dependent upon so many factors, the construction records revealed that the number of bends prepared by the regular bending crew ranged from 8 to 12 per day, whereas the wrinkle bending crew averaged 12 to 16 complete bends per day.

On a large compressor station recently constructed the terrain was such that it was necessary to terrace the ground between the cooling tower and the compressor station. In order to hold excavation and the number of circumferential welds to a minimum it was decided to resort to wrinkle bending. All bends were approximately 28°, the pipe was Grade "B" Seamless. Bends were sharp wrinkles with wrinkles spaced about 8 in. on centre with approximately 5 deg. of bend per wrinkle. No quenching of the bends was allowed. The following bends were prepared in this manner: 8 bends on 24 in. by $\frac{5}{16}$ in. wall pipe; 2 bends on 20 in. by $\frac{5}{16}$ in. wall pipe; 2 bends on 16 in. by $\frac{1}{8}$ in. wall pipe; 2 bends on 16 in. by $\frac{3}{32}$ in. wall pipe.

Upon completion of the header piping, it was hydrostatically tested to approximately $1\frac{1}{2}$ times the maximum working pressure. No failures occurred.

A summary of the advantages to be obtained from wrinkle bending, on pipe lines or in station work, as compared to the conventional method of field pipe bending are in part as follows:

1. Wrinkle bending is the only satisfactory method of bending light-wall pipe.

2. It is the only satisfactory method of bending high-carbon pipe.

3. Mill-coated or yarn-coated pipe may be bent in the field with far less damage to the protective coating, resulting in economic saving.

4. On pipe-line construction, where only occasional and small degree bends are required, such bends may be made by the same crew and equipment employed in the laying gang, without materially delaying the work.

5. A great deal of excavation and time can be saved in rough country as the pipe can be readily wrinkled to fit almost any contour of the ditch rather than having to grade the ditch very carefully to fit the bend or to take great pains in bending the pipe to fit the ditch.

6. From an engineering standpoint, of special importance is the fact that the pipe wall opposite the bends is not thinned from its original thickness and at the point of wrinkling compression squeezes the pipe so that the metal is slightly thicker than the original wall. Furthermore, with this type of bend, the cross section of the pipe receives no distortion and the bend is properly made.

7. Wrinkle bending adapts itself particularly well to the stove pipe method of constructing pipe lines.

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AIR CONDITIONING
A Challenging Opportunity

Abstract of Paper presented at Annual Convention, Natural Gas Section, American Gas Association, Tulsa.

By CHARLES R. BELLAMY

Columbia Gas and Electric Corporation, New York, N.Y., Chairman, Industrial and Commercial Air-Conditioning Committee

A FEW years ago a great many people, including numerous industrial leaders, were expecting a new industry called summer air-conditioning to lead us right out of the depression. But it has not done so, and probably will not, because air-conditioning costs real money. In return it offers more comfortable and healthful living conditions, thereby raising the standard of living, but, as we all know, living standards are closely related to income, and when incomes are low, improvements of this nature are regarded as luxuries.

Instead of a phenomenal growth it has had a steady growth, from a gross business of $10,000,000 in 1931 to an annual business variously estimated from $65,000,000 to $90,000,000. In 1938 when general business declined more than 20% and plumbing and heating dropped 16% from the year before air-conditioning decreased only 11%. This is significant of the industry's position to-day, and it is indeed fortunate from our standpoint that the growth of air-conditioning has been rather slow but sure, because every year has seen a marked improvement in the competitive position of gas equipment.

In speaking of the summer air-conditioning market it is advisable to distinguish between the actual present market and the potential market. The size of the first is based upon present cost of air-conditioning and present business conditions, while the second is dependent upon lower costs and improved business conditions.

An Analysis of the Market

First let us frankly survey the present market. Undoubtedly the most promising and largest outlet at this time is in the commercial field. The thousands of installations in department stores, restaurants, theatres, and other commercial establishments have yielded such good returns to their investors that competitors must either fall in line or lose out entirely. For this reason every store, shop, theatre, hotel, hospital, school, and church is at the present time a potential customer. Less than 25% of the large department stores now have air-conditioning, and only about 10% of the larger restaurants. There are therefore over 3,000 department stores that are excellent prospects, and close to 19,000 restaurants. In addition to this, there are thousands of shops, theatres and hotels which, sooner or later, must install summer air-conditioning.

The second best outlet at this time is probably the industrial field. Here the possibilities of summer air-conditioning are just beginning to be appreciated. True, industrial air-conditioning is relatively old, but generally speaking these older installations were in factories and plants where control of temperature and humidity were obviously imperative. Now, however, the benefits of such control are being demonstrated in all kinds of industries, and the success of these new applications indicates a universal need of air-conditioning by industry.

At the present moment the actual available domestic market is probably only a fraction of the potential market. As the public becomes air-condition conscious—that is, acquainted not only with the comfort but also with the actual benefits of temperature and humidity control—and as general business picks up and equipment costs are lowered, the size of this market will expand. In this connexion it is well to remember that every commercial and industrial installation has an educational value, and it is altogether possible that the popular demand for home air-conditioning will be accelerated by the completely air-conditioned automobile that is ready for marketing.

Large Business Predicted

Altogether the existing market for summer air-conditioning is large, and with the equipment costs reduced and operating performance improved this industry should soon do a gross business of over $100,000,000 per year. One large chemical company recently completed a survey of the air-conditioning market and reached the conclusion that this business should for some time continue to double every three years. One writer estimates a yearly gross of $350,000,000 some time within the next ten years.

Just what percentage of this total business will go to gas it is impossible to say, but it should be a substantial amount. On the assumption that air-conditioning with gas will cost about $300 per ton of refrigeration effect, an annual gross business by gas equipment manufacturers of $100,000,000 would mean roughly 333,000 tons of new installation. Thus annual sales might readily develop a yearly gas load of approximately 9,300 million cu.ft. This should mean something like $5,000,000 of new business to the Gas Industry per annum. In fact, one of our leading utilities, after a most thorough study, has set 10,000 million cu.ft. of gas as the annual new possible business of summer air-conditioning in this country.

Ourusoff,* in his comprehensive analysis of the residential market, found that this business alone might add around $2,260,000 of gross revenue per annum for many years. Figure out what the cumulative effect of such additions would mean to our Industry, and remember that every cu.ft. of such a load is off-peak business. Certainly, here is an opportunity worthy of the best efforts of our Industry! It is indeed the ideal business for us.

In the light of past performance the figures which I have just given may appear optimistic ; but ten years from now they may show up as a very conservative under-estimation. In any event, a large new market for fuel is opening up, and if the Gas Industry is to secure any appreciable portion of this market it must have confidence in its own product. Certainly vision, optimism and confidence are needed to plan our campaign ; for faint heart never won fair lady.

New Capital Needed

Certain manufacturers have already spent large sums of money in developing processes and equipment ; now new capital is needed to develop markets. Here is where the gas utility can step in and help. Gas air-conditioning equipment does not sell itself. It has to be sold. And I think our experience with house heating and refrigeration proves conclusively that successful merchandizing of gas equipment requires the wholehearted backing of the local gas utility.

To put gas air-conditioning across, gas undertakings are going to have to participate with the manufacturers in a campaign of intelligent advertising and sound salesmanship. All this will cost money ; but it should be money well spent, for the summer air-conditioning load is the perfect supplement to our house-heating business. At any given price for gas the air-conditioning load is far more attractive to the gas undertaking than any equivalent volume of house-heating business.

In the realm of general scientific research on the value of air-conditioning regardless of how achieved, recent developments have been most favourable to the cause of gas. As you

* 1938 Report of Industrial and Commercial Air-Conditioning Committee, Industrial Gas Section, American Gas Association.

all know, gas equipment lends itself peculiarly well to the control of humidity. In this connexion the work of the American Society of Heating and Ventilating Engineers during the past summer on the physiological reactions of men while carrying on light work in atmospheric conditions including effective temperatures from 77° to 92° with relative humidities of 60%, 75%, and 90% is very encouraging. Similar tests, using somewhat dryer air, would appear to be desirable, and it seems to me that the American Gas Association should encourage work of this nature.

Tools Available To-day

Now, let us examine carefully the air-conditioning tools that are available to the Gas Industry to-day:

The Gas Engine.—Here is a tool especially suitable in certain locations for large commercial and industrial installations. The possibilities of expanding its field of application appear to be good.

The De-humidifier.—There are at least three well-designed gas-operated de-humidifiers on the market. Here is a tool that has been greatly improved during the past year and its cost reduced anywhere from 30% to 50%. Already favourably regarded in the air-conditioning business for high-class performance, the de-humidifier, now more efficient and lower in cost than ever before, should have a correspondingly broader market. The modern de-humidifier with its cooling system can be used in many sections of our country to provide complete air-conditioning service of the highest order. Wherever refrigeration is imperative the low cost of the new models widens the market for split air-conditioning systems.

The Absorption Refrigeration Machine.—There is one well-designed machine now on the market, and one or two others are expected to be put on commercial production some time this year. Here is a brand new tool, one that can do everything that the conventional electric unit does and more too, for here is the first machine to provide year-round air conditioning.

Examine this array of tools critically, and you will find that it constitutes a matched set of fine instruments. Each instrument has its own peculiar advantages and is unexcelled in certain fields of application. Collectively, these tools cover practically all requirements of air-conditioning, so that wherever natural gas is sold gas-operated air-conditioning equipment should forge to the front. There is high-grade, economical equipment for big installations, little installations, and for the most exacting specifications.

Let us not lose sight, however, of this one very important fact—that while gas equipment is being perfected the manufacturers of electrical equipment are not standing still. Progress is being made on all fronts. Competition is extremely keen, and for some time gas is going to have to work very hard for every bit of air-conditioning business that it gets.

Practically all the equipment that the Gas Industry has been waiting for is now available and on the market. Since this is so, I believe that you will all agree that the time has come for the Gas Industry, especially those companies serving natural gas, to take an active part in the development of the air-conditioning business. A few undertakings have already crossed this Rubicon; but as yet there has been no united action.

What Should be Done?

Some undertakings are asking what should be done. Undoubtedly one of the first steps should be to air-condition gas offices, as has been recommended by several of the A. G. A. committees. By so doing you not only make your customers comfortable, but give a practical demonstration of the value of true air-conditioning. I am glad to say that several of our progressive gas undertakings have already taken this step.

Another step that I believe all the larger undertakings should take is to establish an Air-Conditioning Department headed by a trained engineer. Regardless of the undertaking's policies on appliance sales, this proposed department is needed to advise prospective buyers of air-conditioning systems and to see that gas equipment receives fair treatment in the various set-ups as submitted by local architects and contractors.

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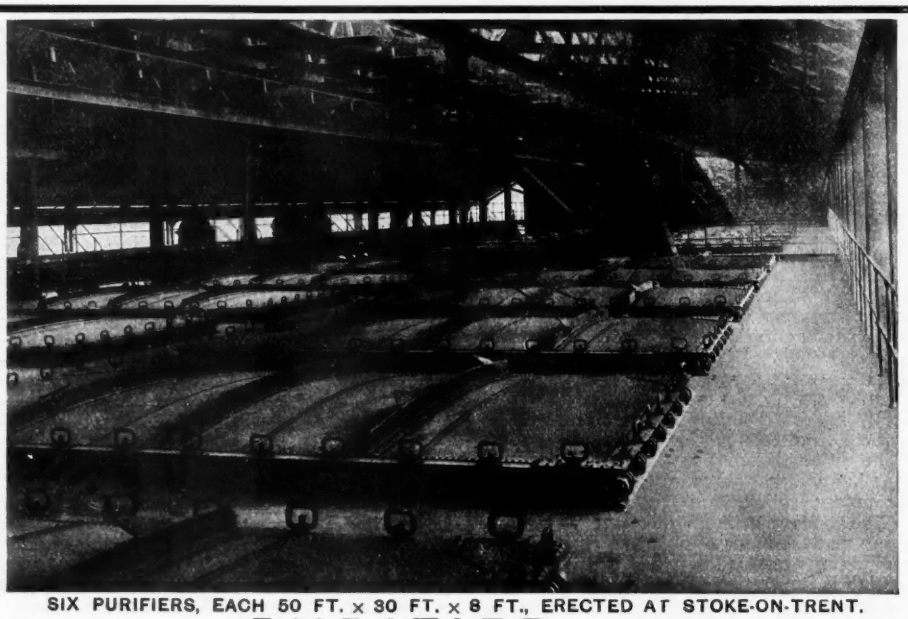

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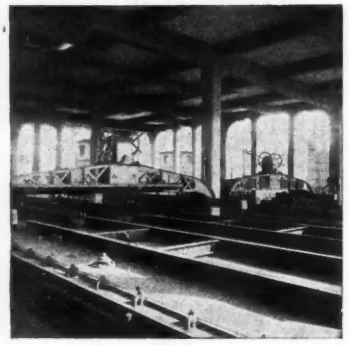

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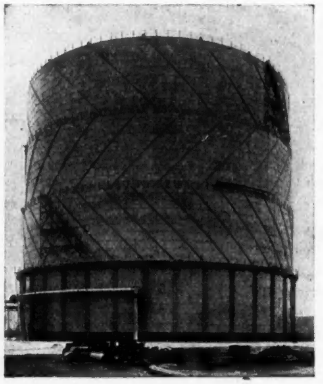

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Markets and Manufactures

Current Sales of Gas Products

The London Market

Aug. 28.

There are no changes to report in the values of tar products, which remain approximately as under:

Pitch, nominal at about 25s. to 26s. per ton f.o.b.
Creosote, 3½d. to 3¾d.
Refined tar, 3¾d.
Pure toluole, 2s. 5d. to 2s. 6d.
Pure benzole, 1s. 9d.
95/160 solvent naphtha, 1s. 7d. to 1s. 8d.
90/160 pyridine, 11s. to 12s.
All per gallon naked at makers' works.

The Provinces

Aug. 28.

Crude Gas-Works Tar, 10s. to 15s.

To avoid misunderstanding, it is necessary to state that the above price is not claimed to represent a market value. It is a price worked out from week to week upon a system which has been used for many years as a basis for the fixing of certain contracts for crude tar of varying qualities in different areas.

The average prices of gas-works products during the week were: Pitch—East Coast, 25s. to 27s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 25s. to 27s.* Toluole, naked, North, 1s. 10d. to 1s. 11d. Coal tar, crude naphtha, in bulk, North 7¼d. to 8¼d. Solvent naphtha, naked, North, 1s. 4½d. to 1s. 5d. Heavy naphtha, North, 1s. 2½d. to 1s. 3d. Creosote, *ex* works, in bulk, North, liquid and salty, 3⅞d. to 4⅛d.; low gravity, 4d. to 4¼d. Carbolic acid, 60's, 1s. 7d. to 1s. 10d. Naphthalene, £13 10s. to £16. Salts, 70s. to 75s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal, "B" quality unsaleable. Heavy oil: Unfiltered anthracene oil, min. gr. 1,080, 4¾d. to 4⅞d.; filtered anthracene oil, min. gr. 1,080, 5¼d. to 5¾d.; heavy tar oil, gr. less than 1,080, 4½d. to 4¾d.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls, whatever they may be.

Scotland

GLASGOW, Aug. 26.

Owing to political tension business has been uncertain during the week, but in most cases works are maintaining their quotations. The future position is unknown but it is not anticipated that there will be any material alteration, at any rate, in the meantime.

Crude gas-works tar.—Actual value remains nominal at about 26s. to 28s. per ton *ex* works in bulk.

Pitch of vertical quality can be secured at about 20s. to 21s. per ton f.o.b. for export and 20s. per ton *ex* works in bulk for home trade.

Refined tar.—Home business is on a moderate scale with works maintaining quotations at 3¾d. to 4d. per gallon. Export business is difficult with value at about 2½d. to 2¾d. per gallon, into buyers' packages at makers' works.

Creosote oil.—New business is not easy to arrange but makers are fairly well sold on contract. Quotations are maintained as follows: Specification oil, 3½d. to 3¾d. per gallon; low gravity, 4¼d. to 4½d. per gallon; neutral oil, 3¾d. to 4d. per gallon; all *ex* works in bulk.

Cresylic acid.—Any new business being placed is for small quantities and prices are easy as under: Pale, 97/99%, 1s. 2d. to 1s. 3d. per gallon; dark, 97/99%, 1s. to 1s. 1d. per gallon; pale, 99/100%, 1s. 4d. to 1s. 7d. per gallon; all *ex* works in buyers' packages.

Crude naphtha is still valued at about 5d. to 5½d. per gallon *ex* works in bulk, according to quality.

Solvent naphtha.—90/160 grade is 1s. 4d. to 1s. 5d. per gallon and 90/190 heavy naphtha is about 1s. 1½d. to 1s. 2d. per gallon.

Motor benzole is 1s. 3d. to 1s. 4d. per gallon.

Pyridine.—Production is well looked after and prices are nominal at 12s. to 13s. per gallon for 90/160 grade and 14s. to 15s. per gallon for 90/140 grade.

Benzole Prices

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole ...	0	9½	to	0	10	per gall. at works
Motor ,, ...	1	3	,,	1	3½	,, ,, ,,
90% ,, ...	1	4	,,	1	4½	,, ,, ,,
Pure ,, ...	1	8	,,	1	8½	,, ,, ,,

Contract Advertised

Coal.

Shipley Gas Department. [p. 518.]

A.R.P. Materials.

Brighouse Gas Department. [p. 518.]

Dividend Announced

Cochran & Company (Annan).—5%, making 7½%, tax free (last year same, on smaller capital).

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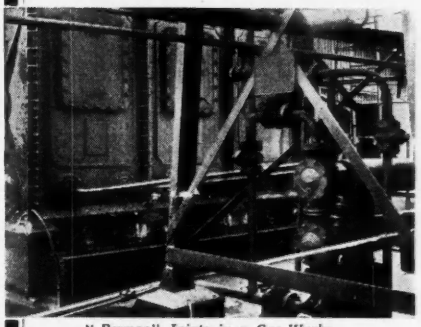
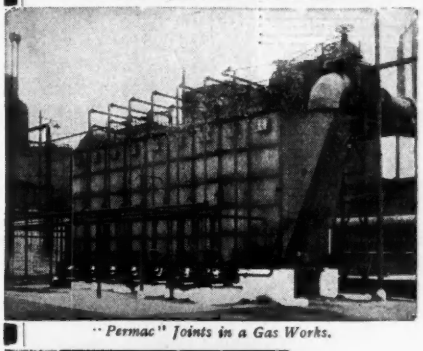
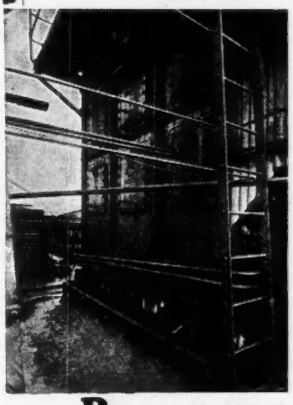


"Permac" Joints in a Gas Works



"Permac" Joints in a Gas Works.



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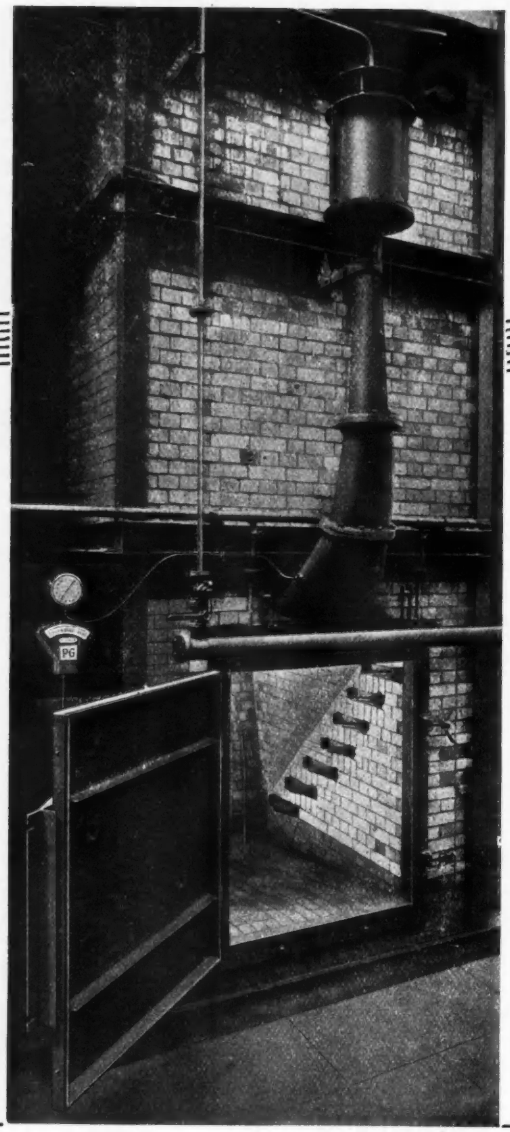

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GAS STOCKS AND SHARES

The crisis was met in the City by prompt action by the Bank of England and the Stock Exchange Committee, the former in raising the Bank Rate from 2% to 4%, and the latter by imposing minimum prices on all classes of gilt-edged securities. Immediately these precautions came into force the volume of business dwindled to negligible proportions as prices widened and there was a general inclination on the part of dealers to take stock. Towards the close, however, markets took a turn for the better, following the fall in sterling. Gilt-edged securities were dealt in round about the minimum prices, and home rails livened up a little, while some good features developed among leading industrials.

Business in the Gas market was on a much reduced scale, and from a first glance at the Stock and Share Lists it would appear that securities in this section have had a bad time. By far the greater number of the reductions, however, were attributable to the usual *ex* div. markings due at this time of the year, although the general position is exemplified by the fall of 3s. 6d. to 17s. 6d. in Gas Light units and of 13½ points to 100 in Imperial Continental ordinary. Commercial also fell 3 to 49½ and South Metropolitan 4 to 77½, and doubtless in the event of any enquiries many other stocks and shares would have reacted similarly. No changes other than ex div. occurred on the Provincial Exchanges, and in the Supplementary List the only fall was that of Oxford ordinary, which closed 12 points lower at 150.

Official Quotations on the London Stock Exchange

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations August 25.	Rise or Fall on Week.
1,767,439	Mar. 6	8	8	Alliance & Dublin Ord. ...	130—140	...
374,000	June 19	4	4	Do. 4 p.c. Deb. ...	88—93	...
877,576	May 8	5	5	Asscd. Gas & Water U'd'ts Ord.	16/—18/–	...
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	18/6—20/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	16/—18/–	– 1/–
318,730	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	15/—17/–	...
750,000	Mar. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	92—97	...
560,070	Aug. 21	7	7	Barnet Ord. 7 p.c.	148—158*	– 2
300,000	Apl. 6	1/4⅝	1/9⅜	Bombay, Ltd.	19/—21/–	...
181,185	Aug. 21	9½	9½	Bournemouth Sliding Scale ...	182—192*	– 3
690,526	,,	7	7	Do. 7 p.c. max. ...	146—151*	– 7
493,960	,,	6	6	Do. 6 p.c. Pref. ...	122—127*	– 3
50,000	June 5	3	3	Do. 3 p.c. Deb. ...	70—75	...
362,025	,,	4	4	Do. 4 p.c. Deb. ...	95—100	...
335,000	,,	5	5	Do. 5 p.c. Deb. ...	110—115	...
357,900	Aug. 21	7½	7½	Brighton, &c., 6 p.c. Con. ...	130—135*	– 3
659,955	,,	6½	6½	Do. 5 p.c. Con. ...	115—120*	– 3
205,500	,,	6	6	Do. 6 p.c. 'B' Pref. ...	108—113*	– 2
855,000	Mar. 20	7	8	British Ord.	102—112	...
100,000	June 19	7	7	Do. 7 p.c. Pref.	136—141	...
350,000	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	June 5	4	4	Do. 4 p.c. Red. Deb. ...	92—97	...
450,000	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105	...
450,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	89—94	...
100,000	22 May '33	6	4	Cape Town, Ltd.	¼—⅜	...
100,000	6 Nov. '33	4½	4½	Do. 4½ p.c. Pref.	¼—⅜	...
150,000	June 19	4½	4½	Do. 4½ p.c. Deb.	58—68	...
626,860	July 17	6	6	Cardiff Con. Ord.	108—113	...
237,860	June 5	5	5	Do. 5 p.c. Red. Deb. ...	102—107	...
98,936	Mar. 20	2/–	2/–	Colombo Ord.	1 3/16—1 5/16	...
24,510	,,	1/4⅜	1/4⅜	Do. 7 p.c. Pref.	21/—23/–	– 1/–
739,453	Mar. 20	–/11.48	–/11.48	Colonial Gas Assn. Ltd. Ord. ...	16/—18/–	...
296,144	,,	1/3.30	1/3.30	Do. 8 p.c. Pref.	21/—23/–	– 1/–
1,775,005	July 31	4	4	Commercial Ord.	47—52	– 3
140,000	Aug. 21	4	4	Do. 4 p.c. Red. Pref. ...	90—95*	...
620,000	June 5	3	3	Do. 3 p.c. Deb.	56—61	– 3
286,344	Aug. 21	5	5	Do. 5 p.c. Deb.	103—108*	– 4
200,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Deb. ...	94— 99*	– 1
807,560	July 31	7	7	Croydon sliding scale	121—126	– 2
644,590	,,	5	5	Do. max. div.	92—97	...
620,385	June 19	5	5	Do. 5 p.c. Deb.	107—112	...
208,660	Aug. 21	5	5	Dudley, Brierley Hill & Dist. Ord.	100—105*	– 4
82,275	,,	5	5	Do. 5 p.c. Con. Pref. ...	100—105*	– 3
79,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Deb. ...	94—99*	– 1
239,000	July 31	5	5	East Hull Ord. 5 p.c.	86—91*	...
187,215	Aug. 21	6	5⅝	East Surrey Ord. 5 p.c. ...	98—103*	– 2
176,211	June 5	5	5	Do. 5 p.c. Deb. ...	105—110	...
250,000	July 3	4	8	Gas Consolidation Ord. 'B' ...	18/6—20/6	...
250,000	May 22	4	4	Do. 4 p.c. Red. Cum. Pref.	17/—19/–	...
19,172,463	July 31	5⅜	5⅜	Gas Light & Coke Ord. ...	16/—19/–a	– 3/6
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	65—70	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	87—92	...
2,993,000	July 3	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	90—95	...
8,602,497	May 22	3	3	Do. 3 p.c. Con. Deb. ...	64—69	– /
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	105—110	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	103—108	...
700,000	Mar. 6	3¼	3¼	Do. 3¼ p.c. Red. Ded. ...	90—95	...
270,466	July 31	6	6	Harrogate New Cons.	95—100	...
157,500	Mar. 20	‡1/–	‡1/–	Hong Kong and China Ord. ...	⅝—¾	...
5,600,000	May 8	8	12	Imperial Continental Cap. ...	95—105	– 1½
172,810	July 31	3½	3½	Do. 3½ p.c. Red. Deb. ...	85—90	...
63,480	June 19	3	3	Maidstone 3 p.c. Deb.	57—62	...
45,000	May 22	†10	†10	Malta & Mediterranean Metropolitan (of Melbourne) ...	128—133	...
392,000	Apl. 6	5½	5½	5½ p.c. Red. Deb.	98—103	...
231,977	Aug. 21	5	5	M.S. Utility 'C' Cons.	93—98*	– 2
968,658	,,	4	4	Do. 4 p.c. Cons. Pref. ...	82—87*	– 1
390,076	June 19	4	4	Do. 4 p.c. Deb. ...	90—95	...
148,955	June 19	5	5	M.S. Utility 5 p.c. Deb. ...	105—110	...
125,000	July 3	3½	3½	Do. 3½ p.c. Red. Bds. ...	92—95	...
675,000	May 8	†6	†3	Montevideo, Ltd.	52—62	...
250,000	Aug. 21	7½	7½	North Middlesex 6 p.c. Con. ...	133—138*	– 2
396,160	July 31	5	5	Northampton 5 p.c. max. ...	101—106	...
300,000	April 24	†9	†7	Oriental, Ltd.	135—145	...
468,537	June 5	7	8	Plymouth & Stonehouse 5 p.c.	112—117	...
621,667	July 31	8½	8½	Portsmouth & Gosport Cons.	132—142	...
241,446	,,	5	5	Do. 5 p.c. max.	95—100	...
73,350	,,	5	5	Do. 5 p.c. Pref.	100—105	...
75,000	,,	4	4	Do. 4 p.c. Pref.	81—86	...
114,000	July 31	5	5	Preston 5 p.c. Pref.	100—105	...
247,966	June 19	4	4	Primitiva 4 p.c. Cons. Deb. ...	95—100	...
625,959	July 17	4	4	Do. 4 p.c. Red. Deb. ...	93—98	...
15,000	Mar. 6	6	6	San Paulo 6 p.c. Cum. Pref. ...	7⅞—8⅜	...
441,275	May 8	1/1½	1/1½	Severn Val. Gas Cor. Ld. Ord.	19/—21/–	...
460,810	Mar. 20	–/10⅝	–/10⅝	,, ,, 4½ p.c. Cum. Pref. ...	18/6—20/6	–/6
133,201	Aug. 21	5	8½	Shrewsbury 5 p.c. Ord. ...	107—117*	– 3
9,000	June 5	‡4	‡4	South African Ord.	4—5	...
1,996,297	Aug. 21	1/2⅝	1/2⅝	South East'n Gas Cn. Ld. Ord.	20/—22/–*	–/6
1,000,000	,,	–/10⅝	–/10⅝	Do. 4½ p.c. Red. Cum. Pref.	18/—20/–*	–/6
769,191	,,	4	4	Do. 4 p.c. Cum. Pref. ...	15/—17/–*	– 1/–
450,000	,,	4	4	Do. 4 p.c. Deb.	95—100*	...
150,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	90—95*	...
6,709,895	July 31	6	5	South Met. Ord.	75—80	– 4
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	115—120	– 1
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	80—85	– 3
1,895,445	June 19	3	3	Do. 3 p.c. Deb.	68—73	...
1,000,000	July 17	5	5	Do. 5 p.c. Red. Deb. ...	103—108	...
600,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Deb. ...	92—97	...
1,543,795	July 31	6	6	South Suburban Ord. 5 p.c. ...	101—106	...
512,925	,,	5	5	Do. 5 p.c. Pref.	101—106	...
500,000	,,	4	4	Do. 4 p.c. Pref.	83—88	...
250,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	89—94	...
888,587	June 5	5	5	Do. 5 p.c. Deb.	105—110	– 2
250,000	,,	4	4	Do. 4 p.c. Deb.	89—94	...
200,000	July 31	3½	3½	Do. 3½ p.c. Red. Deb. ...	89—94	...
427,859	Apl. 6	9½	1/2⅝	S. Western Gas & Water Ord.	15/—17/–	...
160,523	Apl. 6	–/10⅝	–/10⅝	Do. 4½ p.c. Red. Cum. Pref.	18/6—20/6	...
110,000	June 5	4	4	Do. 4 p.c. Red. Deb. ...	92—97	...
750,541	July 31	5½	5	Southampton Ord. 5 p.c. ...	100—105	...
148,836	June 5	4	4	Do. 4 p.c. Deb.	89—94	...
350,000	July 31	5½	5½	Swansea 5½ p.c. Red. Pref. ...	102—107	...
200,000	June 19	3½	3½	Do. 3½ p.c. Red. Deb. ...	89—94	...
1,076,490	July 31	6½	6½	Tottenham and District Ord....	103—108	– 2
409,835	,,	5½	5½	Do. 5½ p.c. Pref.	108—113	...
62,235	,,	5	5	Do. 5 p.c. Pref.	100—105	...
453,380	June 19	4	4	Do. 4 p.c. Deb.	87—92	...
85,701	June 5	6	6	Tuscan 6 p.c. Red. Deb. ...	95—100	...
1,247,505	May 8	4	6	U. Kingdom Gas Cor. Ord. ...	15/—17/–	–/6
1,085,952	May 8	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	17/—19/–	...
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum. Pf.	17/6—19/6	...
745,263	June 5	4½	4½	Do. 4½ p.c. 2nd Non-Cum. Pf.	13/6—15/6	...
1,093,656	Mar. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	92—97	...
378,106	Mar. 6	7	7	Uxbridge, &c., 5 p.c.	117—122*	– 3
133,010	,,	5	5	Do. 5 p.c. Pref. ...	100—105*	– 2
1,371,138	July 31	7	6½	Wandsworth Consolidated ...	107—112	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	82—87	...
1,343,964	June 19	5	5	Do. 5 p.c. Deb.	103—108	– 4
383,745	,,	4	4	Do. 4 p.c. Deb.	89—94	...
400,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Deb. ...	92—97	...
558,342	July 31	6¼	6¼	Watford and St. Albans Ord. ...	107—112	...
200,000	,,	5	5	Do. 5 p.c. Pref.	100—105	...
200,000	,,	5½	5½	Do. 5½ p.c. Pref.	106—111	...
200,000	,,	4	4	Do. 4 p.c. Rd. Pf. (1973/8)	90—95	...
100,000	—	—	—	Do. 4 p.c. Red. Pf. (1959)	97—102	...
200,000	June 19	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...
200,000	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	83—88	...

a.—The quotation is per £1 of Stock. * Ex. Div. † Paid free of income-tax. ‡ For year. § Actual.

Supplementary List and Provincial Exchanges overleaf.

STOCK AND SHARE LIST—Contd.

Supplementary List, not Officially Quoted, London

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Nominal Quotations August 25.	Rise or Fall on Week.
202,152	Mar. 20	5	5	Ascot Ord.	97—102	...
128,182	July 3	5	5	Do. 5 p.c. Pref.	101—106	...
31,035	Aug. 21	–/4⅛	–/4⅛	Associated Utilities 4 p.c. Pref.	15/—17/–*	...
100,000	June 19	3⅛	3⅛	Do. 3½ p.c. Red. Deb. ...	93—98	...
17,000	Aug. 21	8	8	Bognor Orig. Ord. 'A' ...	137—147*	–3
62,210	,,	8	8	Do. New Add. 'A' ...	137—147*	–3
87,160	,,	7	7	Do. New 7 p.c. max. ...	132—142*	–3
37,440	July 31	10	10	Cam. Univ. & Town 10 p.c. max.	160—170	...
125,970	,,	7	7	Do. 7 p.c. max.	115—125	...
39,025	,,	5	5	Do. 5 p.c. max.	95—100	...
96,410	July 17	4½	4½	Cardiff 4½ p.c. Pref.	92—97	...
55,520	July 31	6	6	Colchester 6 p.c. Pref....	113—118	...
90,550	Mar. 20	5	5	Do. 5 p.c. Deb. ...	103—108	...
150,000	July 31	4	4	Croydon 4 p.c. Pref.	84—89	...
130,000	June 19	4	4	Do. 4 p.c. Deb.	90—95	...
65,000	Aug. 21	7¼	7¼	Eastbourne 'A' 5 p.c.	120—130*	–2
198,000	,,	6	6	Do. 'B' 3½ p.c.	103—113*	–2
112,312	,,	5	5	Do. 5 p.c. Pref.	100—105 *	–2
130,000	June 19	5	5	Do. 5 p.c. Deb.	105—110	...
130,500	Aug. 10	7½	7½	Exeter New Ord. (£10) ...	13½—15½	...
24,000	Aug. 21	8½	8½	Gt. Yarmouth 8½ p.c. max. (£30)	24—29*	–1
59,400	,,	7½	7½	Do. 7½ p.c. max. (£30) ...	26—31*	–1
51,160	June 5	5½	5½	Do. 5½ p.c. Deb.	115—120	...
152,600	Feb. 20	8	9	Guildford Cons.	150—160	...
54,055	,,	5	5	Do. 5 p.c. Pref.	102—107	...
68,250	June 5	5	5	Do. 5 p.c. Deb.	103—108	...
156,600	Aug. 21	7	7	Hampton Court Cons. ...	100—110*	–3
86,046	June 19	‡4½	‡5	Holyh'd&N.W.G.&W.Cpn.Ord.	13/6—15/6	...
80,000	Aug. 21	4	4	Lea Bridge 4 p.c. Pref.... ...	78—83*	–2
60,000	,,	6	6	Do. 6 p.c. Pref.	113—118*	–2
94,876	June 5	4	4	Do. 4 p.c. Deb.	87—92	...
73,620	Mar. 6	8¾	8¾	Luton Cons. 'A'	150—160	...
107,960	Mar. 20	4	5½	Mid Kent Ord. (£10)	8½—9½	...
230,940	July 31	10	10	Oxford & District Ord. ...	145—155	–12
47,112	,,	5	5	Do. 5 p.c. Pref.	95—105	+1½
50,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	106—111	...
126,193	May 8	7½	7½	Peterborough Ord.	134—139	...
64,990	Mar. 6	7½	7½	Redditch Ord.	115—125	...
166,850	July 31	8	8	Romford Ord.	137—142	...
60,000	,,	4	4	Do. 4 p.c. Pref.	95—100	...
44,000	Mar. 20	5	5	Do. 5 p.c. Deb.	107—112	...
25,570	July 31	5¼	5½	Rugby 5½ p.c. Pref.	116—121	...
25,000	,,	6	6	Do. 6 p.c. Red. Pref. ...	103—108	...
42,750	June 5	5½	5½	Do. 5½ p.c. Deb.	113—118	...
110,950	Aug. 21	8	8	Ryde Ord.	137—147*	–3
270,086	Mar. 20	7	7	Slough Ord.	120—130	...
21,000	June 5	5	5	Do. 5 p.c. Deb.	103—108	...
28,872	May 8	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	16/—18/–	...
28,866	Mar. 6	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	17/—19/–	...
117,228	Aug. 21	7	5	Swindon Cons.	98—103*	–2
60,425	June 5	5	5	Do. 5 p.c. Deb.	103—108	...
64,380	June 19	5	5	Torquay & Paignton 5 p.c. Pref.	102—107	...
130,000	Aug. 21	8	5	Wakefield Ord.	101—106*	–2
81,650	,,	5	5	Do. 5 p.c. max.	81—86*	–2
82,000	July 31	6	6	Weymouth Ord.	101—106	...
273,626	Aug. 21	7	7	Wolverhampton Cons. Ord. ...	126—131*	–3
98,384	,,	6	6	Do. 6 p.c. Pref.	113—118*	–2
160,000	June 19	5½	5½	Do. 5½ p.c. Red. Deb. ...	102—107	...
106,490	Aug. 21	5½	5½	Wrexham Ord.	89—94*	–2
90,000	June 19	5	5	York 5 p.c. Red. Deb.	102—107	...
133,640	July 31	6½	6	Yorktown (Cam.) 5 p.c. Cons.	112—117	...
120,000	,,	5	5	Do. 5 p.c. Pref.	100—105	...
35,000	June 19	5½	5½	Do. 5½ p.c. Deb.	110—115	...

BRISTOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations August 25.	Rise or Fall on Week
347,756	July 31	6	5	Bath Cons.	113—115	...
1,667,250	,,	5	5	Bristol, 5 p.c. max.	106—108	...
120,420	June 5	4	4	Do. 1st 4 p.c. Deb.	96—100	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	96—100	...
328,790	,,	5	5	Do. 5 p.c. Deb.	113—116	...
274,000	July 31	5	5	Newport (Mon.) 5 p.c. max. ...	93—95	...
13,200	Mar. 20	7	8⅝	Pontyp'l Gas & W. 10 p.c. 'A'	12⅜—13½	...
13,600	,,	6	5	Do. 7 p.c. 'B'	10⅜—11½	...
40,000	,,	6	5	Do. 7 p.c. 'C'	10⅜—11½	...
140,778	July 31	5	5	Weston-super-Mare Cons. ...	102—104	...
64,338	June 19	4	4	Do. 4 p.c. Deb.	97—99	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	146—150	...

LIVERPOOL EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations August 25.	Rise or Fall on Week
157,150	July 31	6½	5	Chester 5 p.c. Ord.	105—108	...
92,500	June 5	4	4	Do. 4 p.c. Pref.	94—98	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	86—89	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	96—100	...
2,167,410	Aug. 21	6	6	Liverpool 5 p.c. Ord.	111—113*	–2
245,500	June 19	5	5	Do. 5 p.c. Red Pref. ...	100—105	...
306,083	July 17	4	4	Do. 4 p.c. Deb.	99—101	...
106,280	July 31	10	10	Preston 'A' 10 p.c.	174—184	...
188,219	,,	7	7	Do. 'B' 7 p.c.	126—136	...

NEWCASTLE EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations August 25.	Rise or Fall on Week
122,577	Aug. 21	8	8	Blyth 5 p.c. Ord.	146½—148½*	–2½
732,000	Aug. 21	3	4	Hartlepool G. & W. Cn. & New	74½—76½*	–1½
2,061,315	July 31	5⅔	5	Newcastle & Gateshead Con.	20/—21/–a	...
682,856	,,	4	4	Do. 4 p.c. Pref.	85—87	...
776,706	June 5	3½	3½	Do. 3½ p.c. Deb.	83—84	–3
277,285	April 24	5	5	Do. 5 p.c. Deb. '43 ...	101—103	...
332,351	Aug. 21	6	6	Sunderland 6 p.c. max. ...	126—128*	–2

NOTTINGHAM EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations August 25.	Rise or Fall on Week
542,270	Aug. 10	9	6	Derby Con.	130—135	...
55,000	June 19	4	4	Do. 4 p.c. Deb.	100—105	...
20,000	June 19	5	5	Long Eaton 5 p.c. Pref. ...	10—12	...
80,000	,,	5	5	Do. 5 p.c. Deb. ...	102—107	...

SHEFFIELD EXCHANGE

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations August 25.	Rise or Fall on Week
10,000	Aug. 21	10	10	Great Grimsby 'A' Ord. ...	180—190*	...
6,500	,,	10	10	Do. 'B' Ord. ...	180—190*	...
79,000	,,	10	10	Do. 'C' Ord. ...	175—185*	...
1,806,339	Feb. 20	6½	6½	Sheffield Cons.	133—136	...
95,000	July 3	4	4	Do. 4 p.c. Deb.	99—101	...

a The quotation is per £1 of Stock.
* Ex. div. ‡ For year.

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